# LiDAR BASED OBJECT DETECTION SYSTEM FOR DRONES

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***Abstract— The key components for the development of autonomous drones are object detection and tracking in real time. With this, LIDAR (Light System and Ranging) sensors are particularly suitable, as they can function in bad weather conditions while providing precise information. However as opposed to the camera photos, the resolution is very poor. However, Deep Learning methodology is applied to 3D LiDAR sensor with low resolution, for this aim we can develop a LiDAR based system that uses a Convolutional Neural Networks (CNN), to perform point wise object detection which estimates the actual position and the velocities of the detected objects. It works as a defense mechanism to protect the drone from birds or other unpredictable objects and avoid them to protect the drone from any harm. It can avoid the object by analyzing its height and width and adjusting the fan speed accordingly. It will also have a feature that if the fans stop spinning at all then a notification and the drone's current location will be sent to the owner of the drone that the drone might be stolen or switched off due to unknown circumstances.***

**Keywords—*LiDAR (Light Device and Ranging), Deep Learning, Artificial Intelligence (AI), Drones, Convolutional Neural Networks* ,3D Mapping.**

## I. INTRODUCTION

Deep Learning on LiDAR information for Object Detection. Traditional computer vision problems namely object recognition, identification and semantic segmentation have been implemented successfully to deep learning techniques and Pre - trained Neural Networks. Some early approaches to the use of CNNs to identify vehicles over 3D LiDAR point clouds use 3D convolutions or sparse3D convolutions to predict the detection scores through voting weights. However, deploying them over point clouds requires high computational power due to the high dimensionality of 3D LiDAR data. Another method adopted is to apply the well-known 2D convolution instruments to the 3D pointcloud over analogous 2D representations.

In project In LiDAR Image Data, target detection. Classic object detection approaches in LiDAR point clouds use clustering algorithms to segment the data, assigning various classes to the final groups. Other methods, such as the one used in this paper as a baseline approach, benefit from prior awareness of the layout of the environment to ease the segmentation and clustering of objects.

## II. EASE OF USE

With the growing use of drone, we require new methods for sensing as well as piloting the drone against any moving obstacle and check new path trajectory. LIDAR sensors are especially suitable to develop autonomous drones. It works as a defense mechanism to protect the drone from birds or other unpredictable objects and avoid them to protect the drone from any harm. It can avoid the object by analyzing its height and width and adjusting the fan speed accordingly. The objectiveis to know and understand the path of obstacle coming towards it and find its interference with drones' path.

In the algorithm, the discrete horizontal and vertical angular values can be treated as coordinates of pixels in digital images, and the farthest and mean distance of each spherical coordinate is used to create the surrounding dataset. The LIDAR will analyze the speed of the object and also the dimensions of the object and will avoid the object based on the smaller angular value, if the vertical angular value is smaller than the horizontal angular value then the drone will move in its y-axis accordingly and if the horizontal angular value is smaller than the vertical angular value then the drone will move in its x-axis. If the horizontal and vertical values are similar then the drone will move in the negative y axis as it is easierand less power consuming.

The Drone will be equipped with the LIDAR setup, which will take input parameters on detection of a moving object. The two values at different times can be analyzed for the approaching speed and direction as well as path prediction of the obstacle coming. Presently the system is used to detect a stationary object, and cannot predict the obstacles in upcoming path. The 3-D space can beused to safeguard the drone. The object avoiding setup can also have google maps API installed anda GPS module which will make the drone completely autonomous. It also can also have texting facilities which can be used if the rotors of the drone stop or the drone is damaged enough to fly at the least possible altitude.

The drone can fly according to the synced google maps API it can travel in air by tracking theposition of the sun during sunny days. While in thecloudy weather and night it can track the horizon. There will be no issue with the detection at night asthe LIDAR has its own light because of which it will work even better in the dark.

## III. LITERATURE REVIEW

Classical computer vision problems such as object recognition, identification and semantic segmentation have been applied with great success to deep learning techniques and Deep convolutional Neural Networks However, deploying them over point clouds implies a high computational burden due to the high dimensionality and sparsity of 3D lidar data. Another method followed is to enforce the well- known 2D convolution tools over the 3D point cloud's corresponding 2D representations.

In this project of Object detection using LiDAR. Classic approaches for object detection in lidar point clouds use clustering algorithms to segment the data, assigning the created group to different datasets. Other strategies, benefit from prior knowledge of the environment structure to ease theobject segmentation and clustering.

## IV. PROPOSED WORKING

The Drone will be equipped with the LiDAR setup, which will take input parameters on detection of a moving object. The two values at different times can be analysed for the approachingspeed and direction as well as path prediction of the obstacle coming. Presently the system is used to detect a stationary object, and cannot predict the obstacles in upcoming path. The 3-D space can beused to safeguard the drone. The drone can also take the angular values and detect at what angle theobject is coming towards it. The LIDAR will createan image of the object and will process the image by calculating the least movement necessary to avoid the object and will run over the decision treeto make a possible prediction and act accordingly. This can be done by adjusting the flaps or the speedof the rotors of the drone. If the drone has to move3cm down then the drone will decrease its speed from say 40mph to 30 mph in such a way that it does not loses it stability and also avoids the objectin feasible time.

## V. METHODOLOGY

- To develop a moving obstacle detection system: We can use this feature in several autonomous vehicle systems and robots to detectobstacles.
- To predict path of obstacle: We can predict the path of the incoming object with speed and angleas parameters.
- Check for the interference and give a safer path: We can predict the path of the incoming obstacle and adjust out drone accordingly to avoid it.

## VI. CALCULATIONS

LIDAR works by emitting a laser beam and measuring the time it takes for the laser to bounce back off of an object and return to the LIDAR sensor. By knowing the speed of light, the LIDAR system can calculate the distance to the object based on the time it takes for the laser to travel to and from the object.

If the object is approaching the drone, the distance between the LIDAR sensor and the object will decrease over time. This change in distance can be measured by comparing the distance measurements obtained at different time intervals.

To calculate the velocity of the approaching object, the LIDAR system can use the concept of Doppler shift. Doppler shift occurs when there is a relative motion between the LIDAR sensor and the object, causing a shift in the frequency of the laser beam reflected from the object. This shift in frequency can be measured by the LIDAR system and used to calculate the velocity of the object towards the drone.

The mathematical formula for calculating the velocity of an approaching object using LIDAR can be expressed as:

$$v = c * ((\Delta f / f) / 2)$$

where v is the velocity of the object, c is the speed of light, Δf is the Doppler shift frequency, and f is the original frequency of the laser beam.

## VII. IMPLEMENTATION

In LIDAR processing values of an approaching object towards a drone depend on the specific LIDAR system and application, but generally involve the principles of time-of-flight and Doppler shift.

The time-of-flight principle can be expressed mathematically as:

distance = (speed of light x time of flight) / 2

where distance is the distance between the LIDAR sensor and the object, speed of light is the speed of light in a vacuum, and time of flight is the time it takes for the laser pulse to travel to the object and back to the LIDAR sensor.

To calculate the velocity of the approaching object, the LIDAR system can use the principle of Doppler shift. The Doppler shift can be expressed mathematically as:

$$\Delta f / f = - (v/c)$$

where Δf is the change in frequency of the reflected laser beam due to the motion of the object, f is the original frequency of the laser beam, v is the velocity of the object towards the LIDAR sensor, and c is the speed of light. The velocity of the approaching object can then be calculated by rearranging the above equation as:

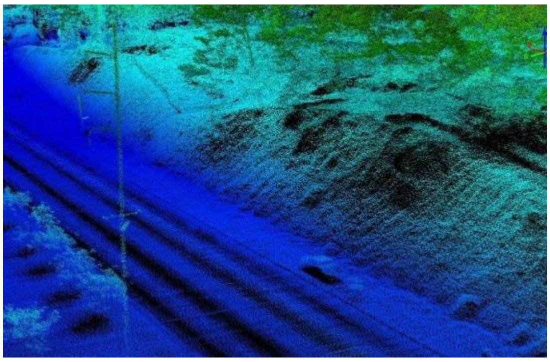
$$v = - (c * \Delta f / 2f)$$

where v is the velocity of the approaching object, c is the speed of light, Δf is the Doppler shift frequency, and f is the original frequency of the laser beam.

## VIII. MULTIPURPOSE USES

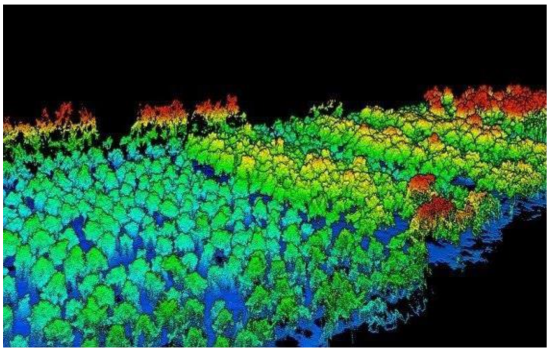
The LiDAR based drones have a lot of uses that can decrease man power efficiently some of them are discussed below:

- **Accident Scenes:**
  LiDAR is an active system which has its own light an does not need any extra light. This helps in the surveillance of the roads for any accident in the night time. It can detect people who need help or are in danger.



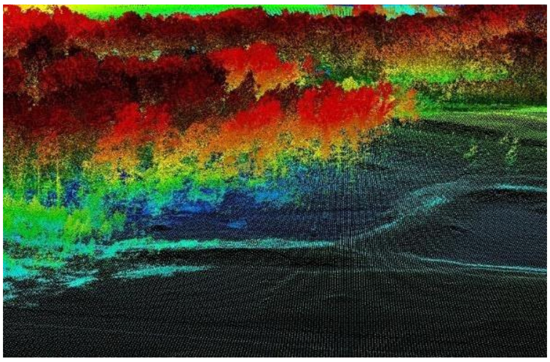
- **Factory and Farming:**

The production of products like maple syrup, paper and other criticalproducts need high maintenance butmaintaining vast fields is a tedious anddifficult job, so to overcome this,drones can be used which can create a real time map of the field which can be looked upon easily. The high resolution 3- D lidars can also be used to capture minute details even in the dark very easily. This eliminates the guesswork and the inefficiencies in the traditional farming.



- **Terrain Modelling:**

The LiDARs can be used tostrategize the best methods to reduce costs by 3D mapping the terrains, even grass and small shrubs. This will prepare the company for moving dirt to set up successfully. It gives a 3D model of topographic terrain contours that groundoperators can work from.

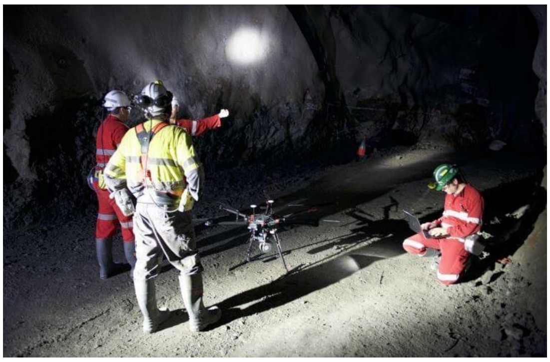


- **Archeology:**

With the use of LiDAR drones/UAVs surveying of large archeologicalsites can be done in a matter of minutes which used to take years to complete if done in the traditional way. These help in the rediscoveringof sites which were considered lost previously.

- **Mine Inspections:**

It can be used to perform Simultaneous Localization and Mapping (SLAM), providing inspection data tobusinesses while allowing the drone to operate semi-or fully autonomously. After a planned collision, this mode of work allows miners to inspect a mine to ensure that the structure is secure before sending any humans.



## IX. RESULT AND DISCUSSION

The main motive of this project was to make the delivery system safer and protect the package fromthefts. But these can also be multi purposed to be used as mapping devices to help the agriculture industry, the surveillance system to detect needy people at night and miners to test the stability of the mine. These drones can be even used in harsh conditions provided the place has enough space forthe drone to pass.

It will protect the package and the drone from the incoming object be it a stone or a bird. This systemcan even send real time notifications to the drone controller about its location and the battery status.

## X. CONCLUSION

A low-resolution LiDAR-based vehicle detection and tracking system was developed in this research. LiDAR technology provides desired robustness and precision under harsh conditions. The autonomous feature can be used for auto pilotof drones or a step ahead in drone delivery system. LiDAR setup with some customization can also beused in other vehicles also.

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